1856 (Bolivia to Argentina) resembles the nominate subspecies. The status of the Brazilian subspecies of the *A. flavirostris* complex was recently reviewed by Silva (*op. cit.*).

### *Individual variation*

One male (MN 38305) from Serra dos Órgãos (Nova Friburgo) shows an ill-defined collar similar to that described by Hellmayr for an intermediate between the interrupted and the complete collar patterns of *semitorquatus* and *taciturnus*. In spite of it, this specimen retains all the other characters of *A. semitorquatus*. The fact that it comes from the centre of the range of *A. semitorquatus*, far from that of *A. taciturnus*, leads us to suppose that this plumage pattern may be of the ontogenetic origin or represent a rare individual variation. This feature alone is not enough to justify the suggestion of intergradation. Two specimens of *A. taciturnus* from Pará (rio Cururu, 07°12′S, 58°03′W) show a similar variation, having an incomplete pectoral band. We have come across other cases of isolated individual variation.

### *Measurements*

The examination of skins of both sexes of *A. semitorquatus* and *A. taciturnus* revealed some notable differences in their measurements. The tail of *semitorquatus* (mean 66.51; s.d. 2.81) is noticeably longer ($t$=12.73, P<0.01) than that of *taciturnus* (mean 58.33; s.d. 3.67). The wing chord of *semitorquatus* (mean 69.8; s.d. 3.23), in contrast to the tail, is usually shorter ($t$=3.27, P<0.01) than that of *taciturnus* (mean 71.95; s.d. 3.49). The bill of *semitorquatus* (mean 12.32; s.d. 0.61) is in general shorter ($t$=6.36, P<0.01) than that of *taciturnus* (mean 13.06; s.d. 0.51).

### *Geographic distribution*

Based on the examined material, *A. semitorquatus* occurs from Espírito Santo (Santa Teresa and Jatiboca) and Minas Gerais (“Fazenda Taveira” and Caparaó), southward through Rio de Janeiro (Três Rios, Cantagalo, Nova Friburgo, Teresópolis and Mangaratiba), São Paulo (Ribeirão Fundo, Serra da Cantareira, Mogi das Cruzes, Cabreuva, Piquete, Rio Grande, Barra do Ribeirão Onça Parda, Salesópolis and Itapetininga), Paraná (Morretes), probably Santa Catarina, to Rio Grande do Sul (Novo Hamburgo). Rio de Janeiro was suggested as the type locality by Berlepsch (in Hellmayr 1938).

In the states of Minas Gerais (Machacalis and Baixo Suassuí) and Espirito Santo (*e.g.* Soretama, Ibiraçu, Baixo Guandu and Rio São José) *A. taciturnus* occupies mainly lowlands, while *A. semitorquatus* seems to be confined to the mountains (*e.g.* Santa Teresa). This rule is not valid from Rio de Janeiro southward, where *A. taciturnus* is absent and *A. semitorquatus* also occurs in lowland areas (*e.g.* Mangaratiba and Morretes). The same phenomenon occurs with *A. taciturnus*, as in the northern portion of its range it is found in the mountains (Serra de Baturité, Serra da Neblina, etc.) as well as in the lowlands (*e.g.* Porto Seguro).

## Final remarks

To conclude, *Arremon semitorquatus* is a good species, found to our knowledge only in Brazil. There is no geographic area where it has been found in sympatry with *A. taciturnus*. The intergradation zone proposed by Hellmayr and Pinto may have been based on misinterpretation of individual variation in the size of the pectoral band. Phylogenetic relationships within this genus are still unclear, and a revision is desirable. The presence of conspicuous sexual dimorphism in *A. taciturnus* (female without pectoral band) is an interesting feature that is not shared by any of its congeners. The taxonomic status of the subspecies of *A. taciturnus* should be scrutinised, especially *A. t. nigrirostris* which lacks good diagnostic characters.

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# What is a desert bird?

### *by P. J. Cowan*

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Desert is arid (low precipitation, high potential evaporation, rare and ephemeral liquid water accumulation on surface) and has a relatively small amount of vegetation. A bird in a desert might be resident, wintering, on migration or have some other temporal status. Spatially, some resident species appear characteristic of the desert whilst other avian desert residents have widespread distributions outside deserts. Some bird species occur in the desert proper whilst others are found in oases.

Many studies of ''desert birds'' have been reported in the scientific literature, including recent reviews by Webster (1991) and Maclean (1996) on ecophysiological aspects of avian survival in deserts. However, defining a desert bird is problematic (Cowan 1990, Wiens 1991) and the particular usage in a study is often not explicit. Lowe (1968) noted that animals referred to as desert species have often included species with a far wider distribution outside deserts. Lowe (1968) distinguished between non-desert species of animals, which occur in ''permissive'' desert environments and are more widespread outside deserts, and desert species which are either ''desert-only'' arid habitat species or ''desert-included'' species occurring in both desert arid habitats and semi-arid regions outside deserts. The present note is intended to further elucidate the question: what is a desert bird?

A desert bird could be a bird species that has evolutionary adaptations to the arid habitats of deserts (Maclean 1976), though any suggested adaptation needs to be proved. Bradshaw (1988) considered that desert reptiles survive due to general reptilian adaptations rather than the possession of unique adaptations to deserts. Birds may only need adaptive refinements to ensure survival in deserts due to favourable general avian adaptations (Miller 1963). Thomas (1984a,b) suggested that desert birds have a multiplicity of relatively minor evolutionary adaptations to deserts the cumulative effect of which is substantial. The discovery that cutaneous evaporative cooling constitutes a major heat defence mechanism in certain columbid birds contrary to previous expectations (Webster 1991), suggests that significant individual adaptations of birds to the arid habitats of deserts may remain to be discovered.

Adaptations to deserts need not be confined to species restricted in distribution to deserts, e.g. birds which migrate through desert regions might acquire desert adaptations (Miller 1963); but species restricted to the arid habitats of deserts presumably would be the most likely to possess significant desert adaptations. An ecogeographic definition of a desert bird therefore should aid in the selection of species for study in the hunt for avian adaptations to deserts.

## What is a desert?

The question of what is a desert bird includes the perennial problem of precisely defining what is a desert. Differing systems of discrete major ecosystem types have been used to describe and map the Earth's terrestrial regions; tundra, desert, tropical rain forest and other major ecosystem types being variously defined using mainly climatic and vegetational criteria (e.g. Bailey 1983, 1989). Numerous other studies have concentrated on arid environments and these have used a wide variety of desert definitions involving, for example, vegetational criteria, the simple specification of isohyets and the use of aridity indices incorporating precipitation, temperature and other climatic variables (review by McGinnies *et al*. 1968). Some authors, e.g. Le Houérou (1977), have restricted their definition of a desert to include only the more extreme arid conditions. Schmidt (1979) presented 12 different delineations of the Chihuahuan desert of North America and a 13th, his version. The ecological zones of North Africa, from the central Sahara desert north to the 400 mm isohyet, presented by Le Houérou (1979) and based on climate, vegetation and land use, are, although he stated otherwise, arbitrary. Different, but equally valid, subdivisions of this region are possible (e.g. Ayyad & Ghabbour 1986). Only arbitrary criteria are available for the distinction between desert and the less arid major ecosystem types (e.g. Whittaker 1975, Beard 1980, Monod 1986, World Conservation Monitoring Centre 1992). The desert concept is subjective and, therefore, any definition of a desert bird is also subjective.

The UNESCO (1979) map of the world distribution of arid and semi-arid regions, based on aridity index values for meteorological stations but supplemented by taking soil, relief and vegetation data into account, is arguably the best general-purpose aridity map yet produced (Verstraete & Schwartz 1991). The aridity index of the UNESCO (1979) map is the ratio P/ETP, where P is the mean annual precipitation and ETP is the mean annual potential evapotranspiration calculated using the Penman formula. P/ETP less than 0.20 is arid. The arid (arid and hyper-arid) regions of this map, but not its semi-arid and sub-humid regions, can be considered to be deserts (Cowan 1987, 1990, 1996, Oberlander 1994).

The world's deserts, using the UNESCO (1979) map, lie between latitudes 50°N and 50°S. Major desert areas occur in North and South America, northern and southern Africa, Asia, and Australia. Polar "deserts" (Logan 1968) are excluded. The high altitude deserts of the Tibetan Plateau are included. The hyper-arid regions of the UNESCO (1979) map are mainly restricted to North Africa and Arabia and are absent from Australia. The arid (arid and extremely arid) areas of its predecessor map, produced by Peveril Meigs for UNESCO, were used by McGinnies *et al*. (1968) and Evenari (1985) for desert delimitation.

Within the perimeter of a desert a distinction exists between desert and oasis. Oases include traditional oases, irrigated agricultural projects, cities and habitats associated with perennial rivers. Lakes or pools in the desert, with associated vegetation, can attract a considerable avifauna of wetland species (e.g. Cowan 1985). Non-arid highlands can also occur within the desert perimeter (e.g. Schmidt 1989). The arid habitats of deserts include the normally-dry valleys, which experience stream flow only after sufficiently heavy rain. Some areas in oases, away from irrigation and water, appear effectively to be arid habitats. Also, previously irrigated agricultural areas return to desert-like conditions.

## Desert birds

The ideal ecogeographic definition of a desert bird would be a species completely restricted in its breeding and non-breeding range to the arid habitats of deserts. Unfortunately, comparison of the distributions of avian species with the boundaries of the world's deserts, the arid and hyper-arid regions of the UNESCO (1979) map, soon reveals a problem. Desert Lark *Ammomanes deserti*, Desert Wheatear *Oenanthe deserti*, Trumpeter Finch *Bucanetes githagineus* and many others of those avian species which appear good candidates for meeting the requirements of the ideal definition (e.g. Casselton 1984), are not completely restricted to the arid habitats of deserts; they can also occur and breed in semi-arid regions outside the desert such as steppe, drier savanna or semi-arid mountains. Apparent desert birds are sometimes found in oasis situations; e.g. Spotted, Crowned and Lichtenstein's Sandgrouse *Pterocles senegallus*, *P. coronatus*, *P. lichtensteinii* drink at permanent pools and village irrigation channels (Thomas & Robin 1977), Black-crowned Finch Larks *Eremopterix nigriceps* are abundant in late summer at a lush desert golf course (Richardson 1990), and in central Saudi Arabia, in late summer, local concentrations of Brown-necked Ravens *Corvus ruficollis* occur near water, including up to 500 at a reservoir on the outskirts of Riyadh (Jennings 1980). Some likely desert birds have occurred as vagrants in countries a considerable distance from deserts, e.g. 33 Cream-coloured Coursers *Cursorius cursor* have been recorded in the British Isles, nine Desert Warblers *Sylvia nana* in Sweden (Lewington *et al.* 1991). Ignoring vagrancy, the Bar-tailed Desert Lark *Ammomanes cincturus* is probably the closest to meeting the ideal definition of the 25 species listed by Casselton (1984) as the desert-associated members of the Sahara desert avifauna.

More realistically, desert birds can be considered as those species which occur primarily within the arid habitats of deserts, any occurrence elsewhere being considerably less important. This definition includes species which are completely restricted to the arid habitats of deserts but excludes, for example, species which occur equally in deserts and semi-arid regions. A desert bird could breed in one desert, migrate with stop-overs in less-arid regions, then overwinter in another desert. The imprecision of the terms "primarily" and "considerably" in the definition adds further subjectivity to any list of desert birds produced. Selection of species for a list of the desert birds of a desert involves assessing from the literature the world distribution of each of the avian species recorded there. I listed 23 (later